

**ATTACHMENT 1  
RFP No. RAM-7-77539**

**APPENDIX A  
STATEMENT OF WORK  
FOR  
INDEPENDENT TESTING OF SMALL WIND TURBINES  
AT THE  
NATIONAL RENEWABLE ENERGY LABORATORY'S  
NATIONAL WIND TECHNOLOGY CENTER  
June 21, 2007**

**1.0 BACKGROUND**

Reducing barriers to wind energy expansion is an important goal for the Department of Energy's (DOE's) Wind and Hydropower Technologies Program. One of the barriers for the distributed wind market is the lack of small turbine systems that are independently tested and certified. The small wind turbine community has long needed a means of distinguishing reliable, safe wind turbine systems from products that do not perform as advertised or are hazardous.

The National Renewable Energy Laboratory (NREL), which is the principal research laboratory for the DOE Office of Energy Efficiency & Renewable Energy, has developed a testing capability that is accredited by the American Association of Laboratory Accreditation (A2LA). The International Electrotechnical Commission (IEC) and the American Wind Energy Association (AWEA) have recently developed standards for testing and evaluating small wind turbine systems. NREL will test commercially available<sup>1</sup> small wind turbine systems at the National Wind Technology Center (NWTC) to the AWEA and IEC standards. Tests will include duration, power performance, acoustic noise emissions, safety and function, and power quality. The Small Wind Certification Corporation, a non-profit organization with support from DOE, AWEA, state energy offices, and turbine manufacturers, may use these test results to certify turbine systems.

**2.0 PROJECT OBJECTIVES**

The independent testing (IT) objectives are to:

- Target commercially available<sup>1</sup> turbine systems that have a high probability of success in the U.S. market over the next several years
- Distinguish reliable, safe wind turbine systems from products that do not perform as advertised or are hazardous
- Provide test results for small turbine systems that are independently tested in an accredited facility
- Post test results on NREL's public Web site that can then be used, for example, by the Small Wind Certification Corporation (SWCC) to certify small wind turbine systems.

<sup>1</sup> Turbine system and spare parts are readily available for sale.

### 3.0 SCOPE OF WORK

The scope of work for the Independent Testing (IT) project requires the Subcontractor to perform the work tasks and attend the meetings described herein. The principal tasks shall include:

- Ensure delivery of complete turbine system
- Provide product documentation to NWTC to facilitate site preparation
- Consult on turbine system installation and train NWTC staff on turbine's operation
- Participate in the turbine system commissioning and acceptance, turbine system operation and maintenance support, and post-test inspection
- Review test and project reports and provide written comments
- Attend Post Test project review meeting.

### 4.0 TASKS

#### **Task 1: Preparation for Installation**

The Subcontractor shall provide documentation as described below. These include procedures and specifications for installing the test turbine system at NREL's NWTC. NREL will use this documentation to prepare test plans, a Safe Operating Procedure (SOP) in accordance with NREL requirements, and test equipment. During this process, NREL may identify problematic discrepancies between the provided information and NREL requirements for safety and integrity with NREL facilities. The Subcontractor shall work with NREL to identify mutually agreeable resolutions to all identified problems prior to turbine system installation.

The Subcontractor shall ship turbine system components and installation equipment as described below to the NWTC. For each shipment to the NWTC, the Subcontractor shall notify NREL of the items being shipped, the expected delivery date, and package size and weight information. In addition, the items MUST be clearly marked such that they can be identified with this project. Items must be received during normal delivery hours between 8:00 AM and 4:00 PM, Monday through Friday. The Subcontractor shall include a detailed packing list with each shipment.

Mail to NREL shall be sent to:

*Recipient's name*, Mail Stop 3811  
National Renewable Energy Laboratory  
1617 Cole Blvd.  
Golden, CO 80401

Non-time-critical shipments to NREL not using U.S. postal service shall be sent to:

National Renewable Energy Laboratory  
*Attn: Recipient's Name, Project Name or Subcontract Number*  
16253 Denver West Parkway  
Golden, CO 80401

Large (more than 800 lb or over 20' long) or time-critical items sent via FedEx or Airborne shall be sent directly to the NWTC at:

National Renewable Energy Laboratory  
National Wind Technology Center,  
Attn: *Recipient's Name, Project Name or Subcontract Number*  
18200 State Highway 128  
Boulder, CO 80303

Large (over 800 lb or over 20' long) or time-critical items sent via UPS or Yellow Freight shall be sent directly to the NWTC at:

National Renewable Energy Laboratory  
National Wind Technology Center,  
Attn: *Recipient's Name, Project Name or Subcontract Number*  
18200 State Highway 128  
Arvada, CO 80007

### **Documentation**

The Subcontractor shall supply the following documentation to NREL:

1. Turbine system description/specifications
  - a. Manufacturer name and address
  - b. Model name
  - c. IEC SWT Design Class and/or design 50-yr extreme wind speed,  $V_{e50}$
  - d. Design turbine system lifetime
  - e. Rotor diameter
  - f. Hub height
  - g. Tower type
  - h. Rated electrical power
  - i. Rated wind speed (lowest wind speed at which turbine produces rated power)
  - j. Rated rotor speed (lowest rotor speed at which turbine produces rated power)
  - k. Rotor speed range during power production.
2. Electrical system description
  - a. Design nominal voltage and frequency at terminals
  - b. Maximum current at terminals
  - c. 1-line drawing showing enclosures, devices outside of enclosures (if any) and wire size/type
  - d. Recommended fuse type and size or circuit breaker setting
  - e. Recommendation for shut-off/lock-out switch size and characteristics.
3. Tower and foundation design calculations. Engineering documents to satisfy a building inspector that the turbine support system is adequate to sustain the design 50-yr extreme wind with the NWTC soil conditions (see Attachment 4).
4. Installation manual or equivalent that includes:
  - a. List of all equipment required for the turbine system and for installation
  - b. Installation procedures and equipment listing/specifications

- c. Commissioning test procedure/checklist
  - d. Bolt-tightening specifications (lubrication or thread-locking compound, and torque).
- 5. Operation manual or equivalent that includes:
  - a. Description of turbine controls, functions, indicating lights, and readouts
  - b. Environmental conditions under which turbine will automatically shut down
  - c. Environmental conditions under which turbine should be manually shut down
  - d. Description of start-up method
  - e. Description of normal shut-down method
  - f. Description of emergency shut-down method
  - g. Description of any self-testing functions.
- 6. Maintenance manual or equivalent that includes:
  - a. Periodic inspection conditions and special conditions that might require inspection (such as after exposure to winds of some specified velocity)
  - b. Scheduled maintenance frequency and activity
  - c. Listing of possible problems, their symptoms, and expected owner response
  - d. Listing and description of repairs that can be executed by an untrained homeowner
  - e. Replacement schedule and cost for any parts not expected to last the full lifetime of the turbine system.
- 7. Critical characteristics required for testing including:
  - a. Predicted tabulated power curve for installation at the NWTC (1845 m above sea level and turbulence intensity at 15 m/s of 12%)
  - b. A list of critical functions of the control and protection system.

### **Turbine System**

The Subcontractor shall supply the following elements of the turbine system to NREL:

- 1. Turbine
- 2. Tower
- 3. Fasteners for connections of the turbine to the tower and between the tower and the foundation
- 4. Wiring as needed to connect the turbine to its controller
- 5. Controller (if intended to be installed out doors, the controller must be housed in an enclosure suitable for exposure to weather conditions at the NWTC.)
- 6. Wiring as needed to connect the controller to the grid at an NREL-provided isolation switch
- 7. Spare parts as required for 18 months of operation
- 8. Special tools as required for installation or maintenance.

### **Task 2: Turbine System Installation**

The Subcontractor shall specify which non-critical activities it wants to observe during installation of the wind turbine. If last-minute variations from the written procedure are

desired by either NREL or by the Subcontractor, NREL will suspend installation until the variation is mutually agreed to and documented.

The Subcontractor shall participate in critical activities during installation at the NWTC to ensure that turbine system installation requirements are met. It is anticipated but not guaranteed that critical activities will occur within a one-week period at the end of installation. The following events are considered critical:

1. Erection of the turbine (placement of the turbine atop the tower or raising of the tower and turbine, if the turbine is a tilt-up)
2. Inspection of the turbine system prior to first connection to the grid commissioning of the turbine system
3. Training of at least one NREL staff member on how to operate the turbine.

The Subcontractor shall provide consultation services as needed at the NWTC to ensure the turbine system installation meets its expectations.

### **Task 3: Turbine System Commissioning and Acceptance**

After completing the turbine system installation, the Subcontractor and NREL shall jointly conduct commissioning tests of the turbine system to ensure manufacturing quality, proper assembly, and absence of observable material defects and to verify functionality, safety, and performance characteristics. As described above in the required documentation listing, the Subcontractor shall provide a commissioning checklist to include equipment inspections, quality assurance checks, and acceptance tests that are typically required by the turbine system manufacturer. Typical commissioning activities include inspections and checkout of the turbine system operating characteristics.

The commissioning tests will include all checks specified by the manufacturer and (if not included in the manufacturer's specification) the following checks required by NREL:

1. Inspection and approval of the electrical installation by an NREL-qualified electrician and, if necessary, by the NREL Facilities Senior Electrical Engineer
2. Acceptable operation of the wind turbine in winds of 8 m/s or higher, including:
  - a. Power production that agrees with power predicted by the power curve
  - b. Stable yaw behavior with a demonstrated ability to track wind direction
  - c. Ability to manually shut down
  - d. Ability to automatically shut down in case of loss of load
  - e. Freedom from excessive vibration
  - f. Freedom from any other observable problems.
3. Verification of adequate training of at least one NREL staff member
4. Other checks as NREL staff may identify based on NREL's review of the turbine system's Operation Manual and control and protection system characteristics.

Any deficiencies noted during the inspections and checkout shall be rectified within one month of being identified and prior to final acceptance. If, for example, the turbine system does not operate as intended, the Subcontractor may arrange for and provide replacement of defective parts, subsystems, or even the entire turbine system. If needed, the Subcontract shall also provide consultation to NREL to install replacement parts,

subsystems or entire turbine system. The Subcontractor shall bear any replacement costs. If the Subcontractor fails to rectify any outstanding deficiency, NREL will assess the severity of the deficiency and its impact on safe operations at the NWTC. If the deficiency is major, NREL reserves the right to terminate the project.

If installation is delayed due to resolution of deficiencies, the Subcontractor shall notify NREL at least 2 working days in advance of the final turbine system commissioning that the deficiency is resolved and that final commissioning is desired.

Both NREL and the Subcontractor shall sign the completed Commissioning Test Report to indicate that the installation and commissioning meet all NREL and Subcontractor requirements. NREL's signature on the commissioning test report also signifies NREL's final acceptance of the wind turbine system. Upon completion of commissioning, verification of instrumentation, and resolution of any safety issues, NREL will authorize unattended operation and begin testing.

#### **Task 4: Turbine System Operation and Maintenance**

Turbine system operation is expected to require operator intervention only as needed to complete testing and to perform inspections and maintenance.

If NREL observes any unexpected behavior or conditions during operation, NREL will notify the Subcontractor as soon as practical. At that time, the Subcontractor shall provide verbal or written guidance for NREL to address the observed issue. Alternatively, the Subcontractor shall come to the NWTC, perform inspections or troubleshooting, and resolve the issue or advise NREL how to resolve the issue. In all cases, NREL will record the observations and all actions taken to resolve the issue.

The Subcontractor shall rectify any equipment failures within one month of being identified. If the Subcontractor fails to rectify any outstanding failure, NREL will assess the severity of the failure and its impact on safe operations at the NWTC and on the overall project schedule. If the failure is major (per the IEC 61400-2 definition), NREL reserves the right to terminate the project.

#### **Task 5: Post-Test Inspection**

The Subcontractor shall participate in the inspection of the turbine system after testing completion. This inspection will be conducted in two steps. First, the turbine system will be inspected while the turbine is in place on its tower. Then the turbine will be removed from its tower, disassembled, and inspected in detail. This detailed inspection will document in pictures and text the efficacy of the turbine system's environmental protection and wear, cracking, or other degradation. The Subcontractor shall document any disagreements with NREL's assessment.

#### **Task 6: Test Documentation Review**

All data generated while conducting the various tests will be public data and posted on the Web. However, prior to release, NREL will prepare drafts of all test reports and other documents (but not progress reports) and provide them to the Subcontractor for

comments. The Subcontractor shall provide any comments on this documentation within two weeks. NREL will consider all comments and will make changes if NREL determines them to be appropriate. The Subcontractor's views, if they are not otherwise accommodated, will be posted along with the reports.

## **5.0 PROJECT REVIEW MEETING**

The Subcontractor shall provide any comments on the efficacy and conduct of the project for internal NREL quality assurance purposes. NREL will not publish comments provided on this evaluation.

The Subcontractor shall attend a Post Test review meeting at the conclusion of the project. The objectives of the meeting include:

1. Feedback to NREL on the scope and execution of the project
2. Discuss specific issues related to all tasks in this subcontract
3. Private discussions of turbine system performance, potential improvements, and future collaboration.

## **6.0 DELIVERABLES**

The Subcontractor shall be responsible for the following deliverables:

<b>Task</b>	<b>Deliverable/Milestone</b>	<b>Due Date</b>
Task 1	Preparation for Installation Complete: All turbine system components received. All documentation received and approved.	1 month after award
Task 2	Turbine System Installation Complete: All installation activities complete and approved by Subcontractor	2 months after award
Task 3	Turbine System Commissioning and Acceptance Complete: Commissioning report signed by Subcontractor	3 months after award
Task 4	Turbine System Operations Complete: Subcontractor provided all necessary support to complete testing.	15 months after award
Task 5	Post-test Inspection Complete: Subcontractor approves of or provides written objections to NREL's post-test assessment	16 months after award
Task 6	Test Documentation Complete: Subcontractor approves of or provides written comments on NREL's test and project reports.	17 months after award
Meeting 1	Post Test Project Review Meeting Complete	18 months after award